Remarks

Thorough examination by the Examiner is noted and appreciated.

Applicants acknowledge a mistaken reference to Specification amendments in the previous amendment.

Claims 7, 11, and 32 have been amended to correct grammatical errors as suggested/required by Examiner.

Although Applicants respectfully suggest that the previous claims implicitly required a separate resist layer removal (ashing), Applicants have explicitly distinguished over the prior art in response to Examiners arguments by amending claims 1, 12, 25 and 32 as disclosed by Applicants in the Specification to place Applicants claims in condition for allowance. No new issues requiring Examiners additional consideration have been raised. Support for the amended claims are found in the original claims and the Specification. No new matter has been added.

Claim Objections

Claim 32 has been amended to overcome Examiners objection as suggested by Examiner which Applicants gratefully acknowledge.

Claim Rejections under 35 USC 112

Claims 7 and 11 have been amended to overcome Examiners rejection under 35 USC 112, second paragraph as required/suggested by Examiner which Applicants gratefully acknowledge.

Claim Rejections under 35 USC 102(e)

Claims 1, 3, 5-13, 20, 21, 23-31 stand rejected under 35 USC 102(e) as being anticipated by Ohuchi (U.S. 6576562).

Ohuchi discloses a method for forming an etched opening in a substrate using a mask material including a carbon content of 80% or more (see Abstract). In Figures 7A through 7F (sixth embodiment with bi-layer photoresist, columns 29-31), Ohuchi discloses and teaches a method for forming an etched opening e.g., a dual damascene using a bi-layer methodology with the upper layer a resist layer.

Ohuchi critically teaches the use of a lower organic layer film has a carbon content of greater than about 80% to provide an increased etching resistance (e.g., col 24, lines 11-54, col 29, lines 33-34) and an upper photoresist film including a metal or semiconductor component disclosed to be silicon, aluminum, titanium, tungsten, and germanium (col 29, lines 44-45).

Ohuchi, by teaching various metals in the alternative to silicon teaches away from Applicants disclosed and claimed invention which is limited to a silicon containing resist, for example, such metals other than silicon may have an adverse effect on light absorption at the wavelengths 157 and 193 as claimed and disclosed by Applicants in independent claim 25. For example, Ohuchi teaches that a conventional upper layer photoresist in a tri-layer embodiment **including an intermediate SOG layer** may broadly be photoactive to a broad range of wavelengths including I-line (365 nm) and g-line (436 nm) wavelengths and (col 14, lines 42-54). Ohuchi does not disclose or teach a wavelength for exposing the metal/semiconductor containing photoresist in the bi-layer embodiment relevant to Applicants disclosed and claimed invention outlined in columns 29-31, thereby failing to disclose Applicants claimed invention and arguably teaching away therefrom.

Examiner argues that "the fourth embodiment exemplifies the use of silicon and a silylation process". Applicants respectfully note that the fourth embodiment is related to etching a gate structure which operates by a different principal of operation that Applicants disclosed and claimed invention of etching an opening.

In addition, Ohuchi teaches that in patterning the upper (second) resist layer to transfer the pattern into the lower organic layer (Applicants first resist layer), that the upper resist layer is removed (col 26, lines 33-35) in-situ during the dry development process contrary to Applicants disclosed and claimed invention as now clearly claimed. Examiner argues that the upper resist layer **can be** removed (ashed) **during etching (dry development)** of the lower organic layer, whereas Applicants disclose and claim **a distinct and separate step** for removing the resist layers e.g., see amended claims 1, 12, 25, 26 and 32 which now clearly and explicitly require a separate removal step thereby addressing Examiner's arguments/concerns. See e.g., claim 1:

"plasma etching according to a second plasma etching process an opening into the substrate according to the etching mask leaving at least a portion of the second resist layer; and,

carrying out an in-situ ashing process **following the plasma etching step** to remove overlying resist layers comprising the first and second resist layers."

Alternatively, Ohuchi **discloses that the overlying bi-layer resists are left in place** to form an overlying wiring grove, acting to "suppress deterioration of the dielectric insulating

film" (col 30, lines 55-65), thereby further teaching away from Applicants disclosed and claimed invention.

Moreover, Ohuchi **does not specifically teach carrying out an ashing process,** particularly a separate and distinct ashing step, to remove the upper (first resist) and/or lower organic (second resist) layers **following formation of a opening** (damascene) as disclosed and claimed by Applicants in independent claims 1, 25, and 32. Ohuchi also does not disclose or teach **a separate ashing step teach** removing the upper resist layer **following the dry development step** (Applicants claim 12) prior to forming the opening or removing the lower organic (first resist) layer following formation of the opening as claimed by Applicants in independent claim 32.

Moreover, Ohuchi does not disclose or suggest that the etching and ashing processes are carried out in-situ or suggest or disclose a plasma cleaning process following formation of the opening including etching through a bottom etch stop layer as claimed in claims 25, 32 and 35.

Significantly, Ohuchi does not disclose any particular thicknesses of the non-silicon containing lower organic layer and upper silicon containing resist film for forming a damascene

opening as shown in Figures 7A-7F in the bi-layer embodiment relevant to Applicants disclosed and claimed invention discussed in columns 29 to 31. Ohuchi does teach, however, that the lower organic layer, disclosed to be a critical part Ohuchi's invention is **thinner** than a conventional resist film due to its superior etching resistance from having a carbon content greater than 80 %, impliedly referring to the upper layer resist (see col 30, lines 37-40). In previous unrelated embodiments for etching a gate structure (1st through 5th embodiments, columns 1-22), Ohuchi discloses that the lower organic layer is from 20 nm to 5,000 nm (col 3, lines 47-48), while the uppermost resist layer is from 5 nm to 10,000 nm (col 15, lines 30-32), allowing **the upper resist layer to be thicker than the lower resist layer**, thereby further teaching away from Applicants disclosed and claimed invention.

Examiner notes that in the tri-layer damascene embodiment of Ohuchi (sixth embodiment for forming damascenes; Fig 7), which includes an intermediate organic silicon oxide film (SOG) (col 25, lines 9-34), that the lowermost high carbon content organic layer is formed at a thickness of 500 nm (col 24, lines 8-10), the SOG film formed at a thickness of 90 nm (col 5, lines 20-22), and the upper resist formed at a thickness of 300 nm (col 25, lines 40-43). However, the tri-layer embodiment of Ohuchi including the intermediate SOG film operates by a different

principal of operation than Applicants disclosed and claimed bi-layer photoresist.

On the other hand, in the bi-layer embodiment of Ohuchi (e.g. without the SOG intermediate layer; column 29 beginning at line 47), relevant to Applicants disclosed and claimed invention, the bi-layers **are taught to be left in place following etching an opening** (col 30, lines 55-65). Therefore, the disclosed thicknesses in the tri-layer embodiment cannot be said to apply to the bi-layer embodiment, where Ohuchi teaches that the lower high carbon content organic layer is advantageously thinner than a conventional photoresist (col 30, lines 37-40), **which is taught to be left in place following etching of the opening** contrary to Applicants disclosed and claimed invention.

Nowhere in the bi-layer embodiment of Ohuchi is it taught or implied that the lower organic layer should be thicker than an upper resist layer as disclosed and claimed by Applicants with respect to first (lower) and second (upper) resist layers.

Examiner argues that Applicants claimed range of thicknesses of the resist layers in claim 7 **allows the lower resist layer to be thinner than the upper layer.** However, Applicants respectfully point out that the claimed ranges depend on the

limitation in Applicants independent claims 1, 25 and 32 which clearly require the upper (second) resist layer to be thinner than the lower (first) resist layer.

Finally, Ohuchi fails to recognize or suggest a solution to the problem that Applicants have recognized and solved by their claimed invention:

"A method for etching an opening using a bi-layer photoresist to improve an etching resolution and reduce particulate contamination".

Ohuchi is clearly insufficient to anticipate Applicants disclosed and claimed invention.

Claim Rejections under 35 USC 103(a)

Claim 22, stands rejected under 35 USC 103(a) as being unpatentable over Ohuchi above, and further in view of Smith (U.S. Pat No. 6,388,226).

The comments made above with respect to Ohuchi are reiterated.

Smith discloses an improved low-field toroidal plasma source (see Abstract). Smith discloses that the plasma source can be operated to increase the etch rate of organic materials (see

Abstract). Smith generally discloses that oxygen is useful for removing photoresist in an etching process (col 1, lines 60-65) and generally discloses that adding a noble gas such as argon to a plasma can increase the output of active species (col 15, lines 29-43), for example in a nitrogen/oxygen plasma. Smith does not teach using a nitrogen/oxygen plasma to dry develop a photoresist layer or disclose a bi-layer or multi-layer resist or a method for developing or etching the resist. There is no motivation to combine Smith with Ohuchi, and in any event, such combination does not produce Applicants disclosed and claimed invention.

Moreover, Smith discloses that argon increases the removal rate of photoresist (col 15, lines 53-55), thereby being inconsistent with Ohuchi's disclosed embodiment of leaving the resist layers in place, since the addition of argon would likely make this embodiment unworkable.

"A prior art reference must be considered in its entirety, i.e., as a whole including portions that would lead away from the claimed invention." *W.L. Gore & Associates, Inc., Garlock, Inc., 721 F.2d, 1540, 220 USPQ 303 (Fed Cir. 1983), cert denied, 469 U.S. 851 (1984).*

"If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references

are not sufficient to render the claims prima facie obvious." *In re Ratti, 270 F.2d 810, 123, USPQ 349 (CCPA 1959).*

With respect to the remaining independent claims, since neither Ohuchi nor Smith nor any combination thereof produce Applicants claimed invention, thereby failing to make out a *prima facie* case of obviousness, neither has a *prima facie* case of obviousness been made out with respect to the amended claims as presented.

The Claims have been amended to clarify Applicants claimed invention in response to Examiners argument/comments to distinguish over the prior art. A favorable consideration of Applicants' claims is respectfully requested.

Based on the foregoing, Applicants respectfully submit that the Claims are now in condition for allowance. Such favorable action by the Examiner at an early date is respectfully solicited.

In the event that the present invention as claimed is not in a condition for allowance for any other reasons, the Examiner is respectfully invited to call the Applicants' representative at his

Bloomfield Hills, Michigan office at (248) 540-4040 such that necessary action may be taken to place the application in a condition for allowance.

Respectfully submitted,

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